National Aeronautics and Space Administration

Manufacturing

Ultrasonic Stir Welding

A new solid-state weld process for better weld quality and longer tool life

NASA Marshall Space Flight Center (MSFC) developed Ultrasonic Stir Welding (USW) to join large pieces of very high-strength metals such as titanium and Inconel. USW, a solid-state weld process, improves current thermal stir welding processes by adding high-power ultrasonic (HPU) energy at 20 kHz frequency. The addition of ultrasonic energy significantly reduces axial, frictional, and shear forces; increases travel rates; and reduces wear on the stir rod, which results in extended stir rod life. The USW process decouples the heating, stirring, and forging elements found in the friction stir welding process allowing for independent control of each process element and, ultimately, greater process control and repeatability. Because of the independent control of USW process elements, closed-loop temperature control can be integrated into the system so that a constant weld nugget temperature can be maintained during welding.

BENEFITS

- Improved weld properties
- Increased tool life (stir rods, bushings, containment plates)
- Automated closed-loop feedback control
- Potential for integration into robotic welders
- Reduced axial and shear consolidation forces
- Potential for handheld version
- Reduced friction without lubricants

APPLICATIONS

The technology has several potential applications:

Aerospace – hardware for severe environments, launch vehicles, aircraft

Automotive –pistons, struts, vehicle structure

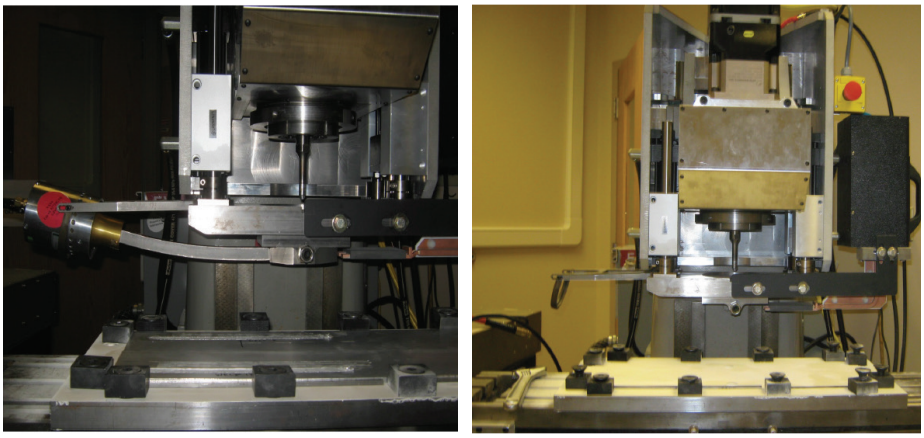
Marine – shipbuilding, platforms

Civil – bridges, trains, pressure vehicles

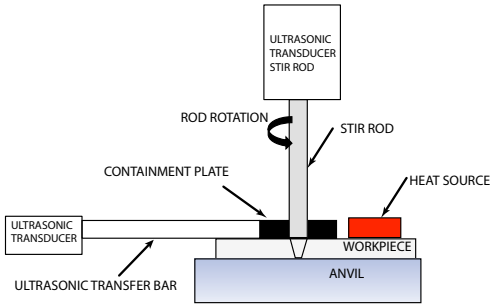
technology solution

THE TECHNOLOGY

Ultrasonic Stir Welding is a solid state stir welding process, meaning that the weld work piece does not melt during the welding process. The process uses a stir rod to "stir" the plasticized abutting surfaces of two pieces of metallic alloy that forms the weld joint. Heating is done using a specially designed induction coil. The control system has the capability to pulse the high-power ultrasonic (HPU) energy of the stir rod on and off at different rates from 1-second pulses to 60-millisecond pulses. This pulsing capability allows the stir rod to act as a mechanical device (moving and stirring plasticized nugget material) when the HPU energy is off, and allowing the energized stir rod to transfer HPU energy into the weld nugget (to reduce forces, increase stir rod life, etc.) when the HPU energy is on. The process can be used to join high-melting-temperature alloys such as titanium, Inconel, and steel.



Photographs of the Ultrasonic Stir Welding equipment



Ultrasonic Stir Welding Process

Diagram of the basic components of the Ultrasonic Stir Welding technology

PUBLICATIONS

U.S. Patent No. 8,393,520
U.S. Patent No. 8,393,523
U.S. Patent No. 7,568,608

Patent Pending.

More Information

National Aeronautics and Space Administration

Sammy A. Nabors

Marshall Space Flight Center

Huntsville, AL 35812
256.544.5226
sammy.nabors@nasa.gov

http://technology.nasa.gov/

www.nasa.gov

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